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ARMY GEOSPATIAL CENTER
ENABLING GEOSPATIAL INFORMATION DOMINANCE

BuckEye HR3D
High Resolution 3-Dimensional Data

Presented to the
Combined Air Operations Center (CAOC)
April 3, 2019

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The Overall Classification of this Briefing is
UNCLASSIFIED//FOUO

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Overview

- BuckEye Program and Platforms
- BuckEye Tasking
- BuckEye Collecting
- BuckEye Processing
- BuckEye Products and Exploitation
- BuckEye Dissemination
- Current Deployments
- Points of Contacts

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BuckEye Program and Platforms

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BuckEye Program

- The BuckEye Program was developed as Quick Reaction Capability (QRC) in 2004 out of the need to rapidly collect, process, and distribute unclassified high-resolution and high-accuracy color imagery for tactical missions.
- As BuckEye capabilities evolved, a Light Detection and Ranging (LIDAR) sensor was added to collect high-resolutions, high-accuracy elevation data supporting improved battlefield visualization and line of sight analysis.
- Today, BuckEye High-Resolutions 3-Dimensional (HR3D) is the basis for developing a multipurpose spatial data infrastructure that can aid countries in their development, internal security, preparedness for humanitarian assistance, and disaster response scenarios by providing wide area, high-resolution, color, **UNCLASSIFIED//FOUO** imagery and elevation data that can be shared among interagency and international partners for both military and civilian applications.
- Currently, there are four variations of the BuckEye platform, all providing HR3D data: BuckEye 2 (BE2), BuckEye Enhanced Capability (EC), BuckEye Unmanned Aerial System (UAS), and BuckEye Terrestrial.

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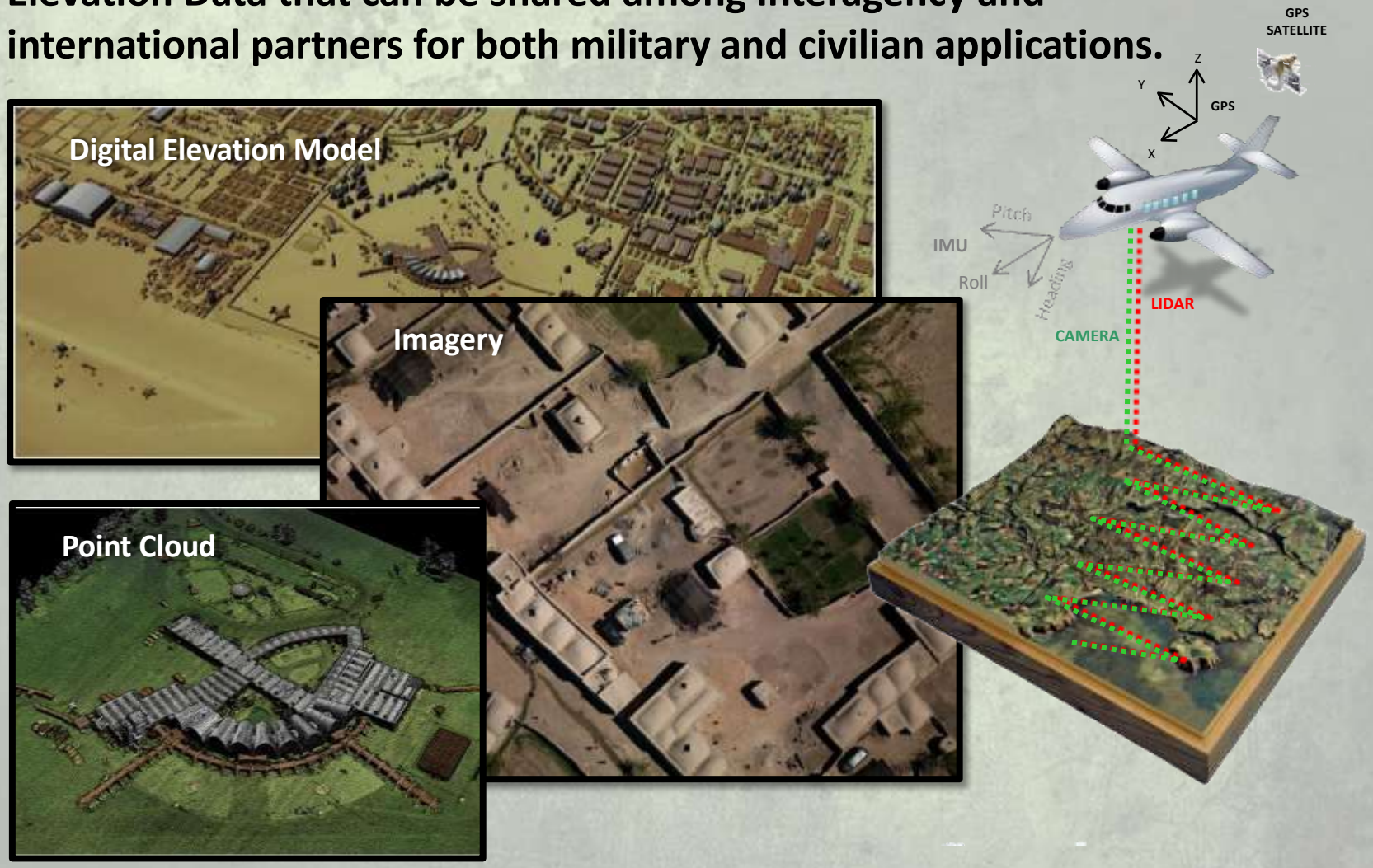
What is BuckEye HR3D

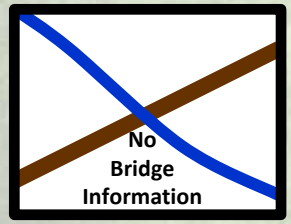
High-Resolution, Color, UNCLASSIFIED//FOUO Imagery and Elevation Data that can be shared among interagency and international partners for both military and civilian applications.



Feature Data Content and Scale

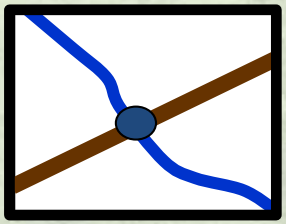
Bulk of Terrestrial Force / SOF Requirements

Strategic



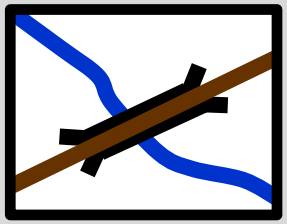
1:1M Tactical Plottage Chart (TPC)

Operational



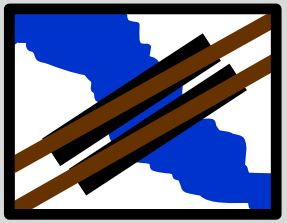
1:250K Joint Operational Graphic (JOG)

Tactical



1:50K Topographic Line Map (TLM)

Urban



1:10K Urban

Programmatic & Production Gaps

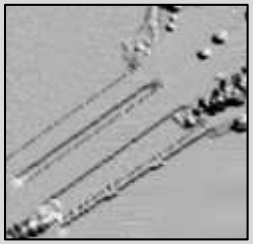
ANALYTICAL EFFORT

COST AND PRODUCTION CYCLE

BANDWIDTH – PROCESSING – STORAGE

FEATURE DETAIL – ACCURACY – CURRENCY

LOW FIDELITY ***HIGH FIDELITY***



Bridge Ref. No. = 2342656
Use = Road Bridge
No. of Spans = 2
Width = 20M
Length = 300M
Overhead Clearance = 10M
Under Bridge Clearance = 40M
Military Load Class = 70

Imagery – Elevation – Attribution

NOTE: BuckEye imagery and elevation data collected near Camp Lejeune in October 2015. Note that imagery/elevation graphics are flipped/mirrored for the purposes of this slide.

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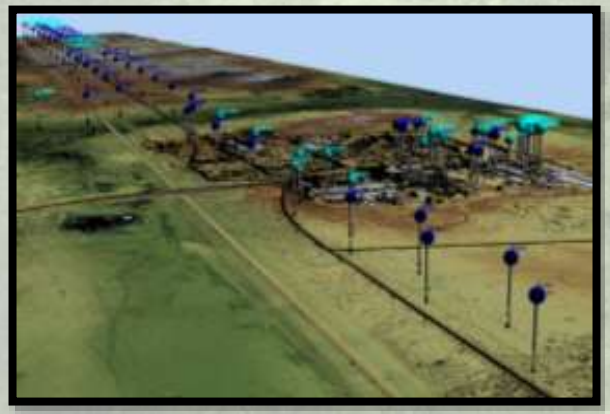
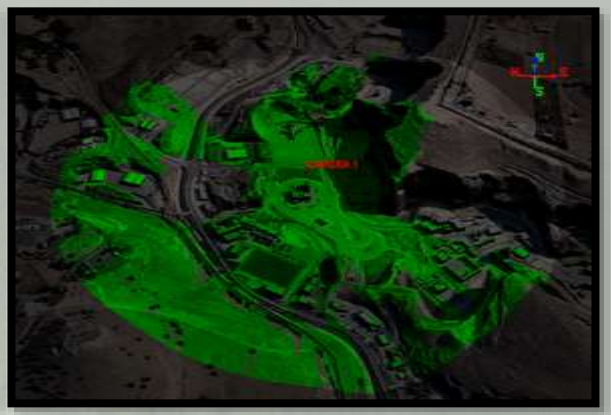
BuckEye HR3D Data Provides



Accurate Vertical Obstruction Data

3D Extracted Features

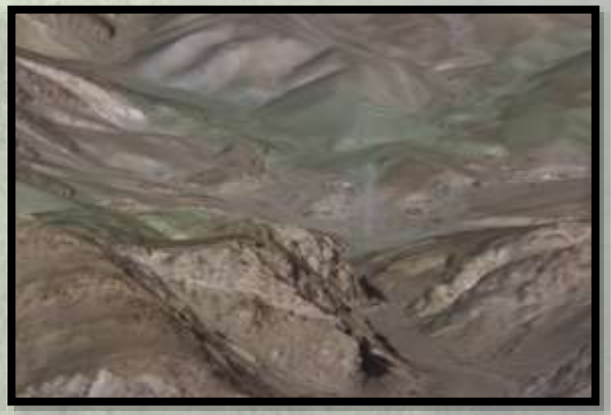


Detailed LOS based on real terrain

Soldiers to Visualize and Understand the Terrain

Detailed Situational Awareness

Detailed Mission Analysis



3D Visualization

An accurate and precise foundation for all sensor and operations data

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BuckEye HR3D Data Provides

Cadastral Mapping / Land parcels / Governance
Addressing / Services / Taxation

Agricultural Mapping

Flood Modeling / Disaster Preparedness
Hazard Mitigation

Transportation / Construction Planning

Environmental Mapping , Spills, Dredging

Forestry / Natural Resource Mapping

Access - Partnerships - Stability

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Benefits of BuckEye HR3D

- Supports US/Coalition Forces (CF)/Host Nation (HN) preparation of the environment and mission analysis
- Shareable with CF and HN partners due to its **UNCLASSIFIED//FOUO** nature
- Aids in building capacity within CF and HN
- Facilitates relationship building with CF and HN
  - Opportunities to work with military and civilian government officials
- Supports planning for Humanitarian Assistance and Disaster Response (HADR) operations
- Aids in establishment of governance and stability
- Supports Security Cooperation Operations (SCO)

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BuckEye Aerial Platforms

AGC

Collection Altitude
Above Ground Level (AGL)

BuckEye 2

Gulfstream GIV

Sigma Space SPL100HA

25,000' AGL

VisionMap MIST-E

BuckEye Enhanced Capability (EC)

King Air 350

Leica ALS80UP

18,000' – 9,000' AGL

Aeroptic 2.5
(Dual 300mm)

BuckEye Arrow UAS

Optech Galaxy

10,000' – 5,000' AGL

Aeroptic 2.5 (200mm)

Aircraft

LIDAR

Electro-Optical
(EO)

NOTE: The King Air 350 platform can be fitted with the LIDAR/EO suite from the UAS or the BE2.

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BuckEye 2

(Quantity: 1)

Gulfstream GIV

- Wingspan: 77’10”
- Length: 88’4”
- Height: 24’ 5”
- Fuel Capacity: 4,880 gal
- Fuel Type: Jet A/A1/B
- Cruising Speed: 533 knots
- Collection Speed: 220 Knots
- Heavy Maintenance: 36/72mos
- Ceiling: 45,000’ AGL
- Endurance: 8+ Hours
- Range: 4,220 NM Transit
- Requires 6,000’ runway
- Provides co-collected 5-10cm geo-registered, ortho-rectified, color imagery and 1m resolution elevation data, all U//FOUO
- BuckEye 2 collects up to 25,000’ AGL and approximately 1,500 km^2 per mission
- White-tailed aircraft **Contractor Owned Contractor Operated (COCO)** with no external sensors; nadir looking only
- Flight pattern “mows the lawn” for wide area mapping

LIDAR: Sigma Space SPL100HA

Nominal Collect Altitude: 25,000’ AGL
Data Swath Width: 2000 m
LIDAR SWAP: 70” x 21” x 19” / ~346.5 lbs/28 VDC
GSD: 50 cm
Laser Power: 15 W
Wavelength: 532 nm
Pulse Rate: 32 kHz
Type: Single Photon

EO: Vision Map MIST-E

Collect Rate: ~250 km^2 per hour
EO SWAP: 14.5” x 13” X 10” / 25.5 lbs / 24-32 VDC
GSD: 10 cm
Megapixels: 9
Frame Rate: 13.7/s
Focal Length: 300 mm

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BuckEye EC

(Quantity: 5)

King Air 350

- Wingspan: 57’ 11”
- Length: 46’ 8”
- Height: 14’ 4”
- Fuel Capacity: 832 gal
- Fuel Type: Jet A/A1/B; JP 4/5/8
- Cruising Speed: 300 Knots
- Collection Speed: 200 Knots
- **Phase Maintenance every 200 hrs**
- Ceiling: 35,000’ AGL
- Endurance: 9+ Hours
- Range: 2,311 NM Transit
- Requires 5,100’ runway
- Provides co-collected 5-10cm geo-registered, ortho-rectified, color imagery and 1m resolution elevation data, all U//FOUO
- BuckEye EC collects up to 18,000’ AGL and approximately 500 km^2 per mission
- White-tailed **COCO** aircraft with no external sensors; nadir looking only
- Flight pattern “mows the lawn” for wide area mapping

LIDAR: Leica ALS80UP

Nominal Collect Altitude: 18,000’ AGL
Data Swath Width: 1550 m
LIDAR SWAP: 26” x 15” x 11” / ~220 lbs/30 VDC
GSD: 1 m
Laser Power: 20 watts
Wavelength: 1064 nm
Pulse Rep.: 35 - 500 kHz
Type: Linear

EO: Aeroptic Dual Mapping Camera

Collect Rate: ~160 km^2 per hour
EO SWAP: 11” x 16” X 17” / ~28lbs / 10A AC
GSD: 10 cm
Megapixels: 80
Frame Rate: 1.0/s
Focal Length: 300 mm

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BuckEye Arrow UAS

(Quantity: 1 System/2 Aircraft + Ground Station)

BuckEye Arrow UAS

- Wingspan: 23’
- Length: 19’
- Height: 6’ 6”
- Fuel Capacity: 50 gal
- Fuel Type: Low Lead 100 Octane AVGAS
- Cruising Speed: 100 Knots
- Collection Speed: 70 Knots
- Ceiling: 12,000’ MSL
- Endurance: 6 Hours
- Range: 50 NM Transit
- Runway: 1,500’ (paved/unpaved compacted)
- Provides co-collected 5-10cm geo-registered, ortho-rectified, color imagery and 1m resolution elevation data, all U//FOUO
- BuckEye UAS collects up to 5,000’ AGL and approximately 60 km2 per mission

Ground Station

LIDAR: Optech Galaxy

Nominal Collect Altitude: 5,000’ AGL
Data Swath Width: 374 m
LIDAR SWAP: 12” x 12” x 12”/ ~55 lbs/ 30 VDC
GSD: 50 cm
Laser Power: 20 watts
Wavelength: 1064 nm
Pulse Rep.: 50 - 1000 kHz
Type: Linear

EO: Aeroptic 2.5

Collect Rate: ~15 km^2 per hour
EO SWAP: 11” x 16” X 17” / ~25 lbs / 155 W
GSD: 5 cm
Megapixels: 80
Frame Rate: 1.0/s
Focal Length: 200 mm

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BuckEye Platform Comparison

AGC

BuckEye 2/SPL100HA

BuckEye EC/ALS80UP

BuckEye UAS/Galaxy

Nominal Collection Altitude (AGL)

25,000’

18,000’

5,000’

Swath Width

1,800m-2,000m

1,000m-1,400m

300m-500m

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BuckEye Terrestrial

(Quantity: 1)

BuckEye Terrestrial provides unique ground-level Geospatial Intelligence (GEOINT) to the soldier. This advanced capability adds a new level of detail and realism to current urban battlefield modeling techniques. BuckEye Terrestrial is configurable for a variety of missions including off-road, highway speed, and waterborne collections.



Dual Lynx Mobile Mapper M-1 Sensor

- Rate – 500 kHz x2 (up to 1 million pts/sec, plus RGB)
- Range – 300 m maximum, 200 m effective.
- 2 cm point distribution at 20 m
- 55 mph maximum effective collection speed.
- Laser safety - Eye safe

4 Lynx Cameras

- FPS (Frames Per Second): 3
- Megapixels: 5
- 2560 x 1920 Pixels

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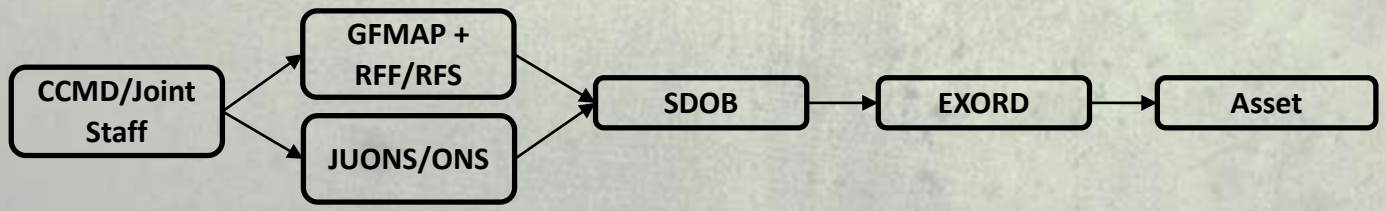
BuckEye Tasking

BuckEye Tasking

(To get in theater)

- **<u>Tasking for a BuckEye collection is not a straightforward process, that is, customer requests sent to AGC do not equate to 'tasking' the HR3D program.</u>**
- The process for Combatant Commands (CCMDs)/Joint Staff involve capturing the need for HR3D data in the Global Force Management Allocation Plan (GFMAP) and a Request for Forces (RFF)/Support (RFS) **or** by submitting Joint Urgent Operations Needs Statement (JUONS) or Operational Needs Statement (ONS) identifying a lack in capability.
- Coordination then takes place between AGC and the CCMD/Joint Staff:
  - Secretary of Defense Operations Book (SDOB) approval
  - Execution Order (EXORD) to AGC
- Once all planning and coordination are accomplished, the asset can be deployed into theater.

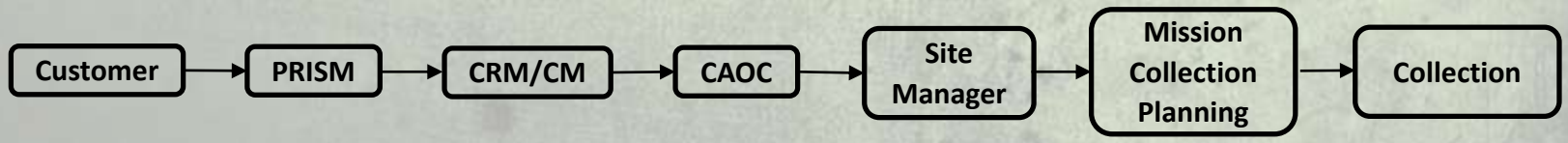


Note: For all BuckEye tasking questions contact BuckEye@usace.army.mil

BuckEye Tasking

Kuwait (CENTCOM)

- Collection request are submitted on Planning tool for Resource Integration, Synchronization and Management (PRISM) ("**Unclassified, 10cm imagery/1m LIDAR" are BuckEye tasking words**).
- Combined Joint Task Force (CJTF) CJ2 Intelligence, Surveillance and Reconnaissance - Division (ISR-D) Collections Requirement Manager (CRM) and the GEOINT Collection Manager (CM) at Arifjan filters requests, prioritizes, and sends to Combined Air Operation Center (CAOC).
- **CAOC ISR-D sends approved nomination numbers with grid coordinates for the week's collection deck via Secure Internet Protocol (SIPR) to site manager.**
- Site manager works with technical lead to plan collection before requesting airspace.
- GEOINT CM at CAOC - DSN: 318-436-1796 or 308-436-2059

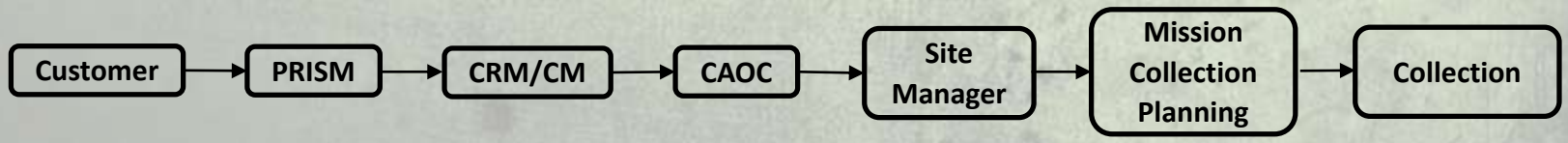


Note: For all BuckEye tasking questions contact BuckEye@usace.army.mil

BuckEye Tasking

Afghanistan (CENTCOM)

- Collection request are submitted on PRISM ("**Unclassified, 10cm imagery/1m LIDAR" are BuckEye tasking words**).
- Train, Advise, Assist Command (TAAC) CM filters requests, prioritizes, and sends to CAOC.
- **CAOC ISR-D sends validated nomination numbers with grid coordinates for the week's collection deck via SIPR to site manager.**
- Site manager works with technical lead to plan collection before requesting airspace.



Note: For all BuckEye tasking questions contact BuckEye@usace.army.mil

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BuckEye Collecting

BuckEye Data Collection

Typical Mission

- Daylight collect, usually between 1000-1400 or when the sun is at less than a 25 degree angle to avoid long shadows.
- Typical mission duration is 8 hours with 5 hours of data collection and 60-1500 km^2 of data collected (Dependent on travel time to the collection site and BuckEye platform).

Types of Data Collected

- BuckEye LIDAR (1 m resolution)
  - LAS point data compressed with LasZip – 16.9 MB/km^2
  - Edited gridded data set in GeoTIFF format – 14.3 MB/km^2
- BuckEye Color EO (10 cm resolution)
  - Orthomosaic (MrSID Compressed Format) – 15 MB/km^2

LAS Format GeoTIFF Format MrSID Format

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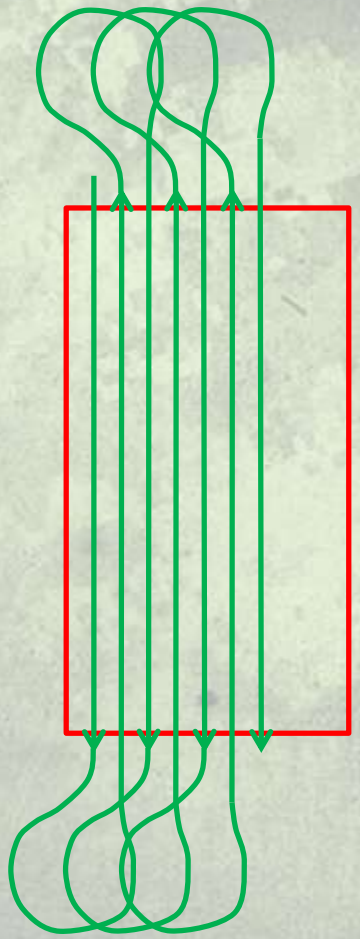
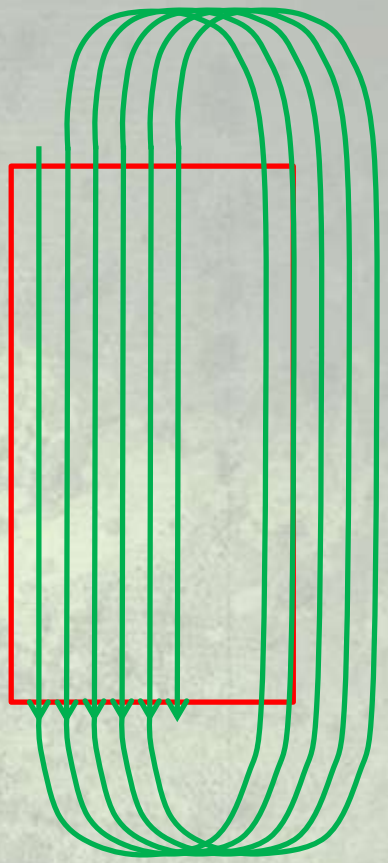
Data Collection Methods



Mowing the Grass
(Preferred)



Race Tracking
(Near Border Operations (NBO),
Restricted Operating Zone (ROZ),
Heavy winds)

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Data Collection EO Footprint

~37% overlap between first and second row of images

~14% image overlap between cameras

~45% image overlap between lines 1 and 2

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Data Collection LIDAR Footprint

~10-30% overlap between lines

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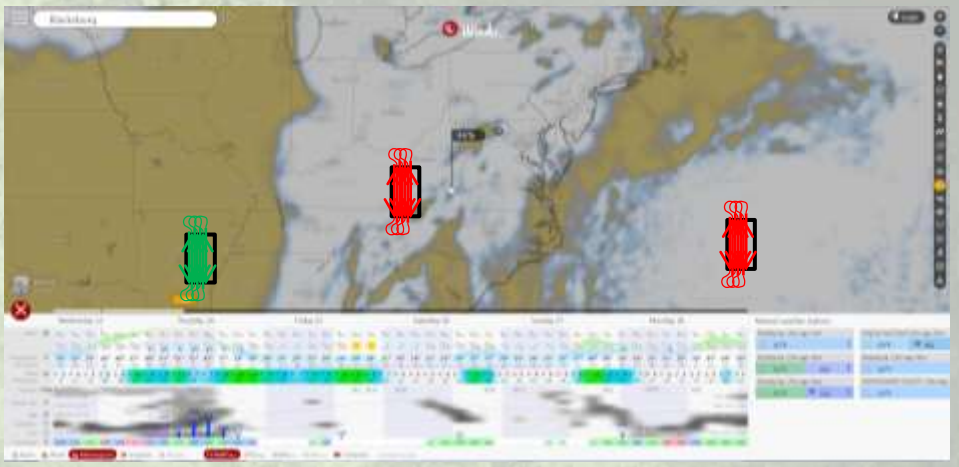
BuckEye Data Collection



Considerations

- The BuckEye Site Manager needs all approved collection requests to maximize efficiency of the collection platform (If weather prevents collection of one area, alternate sites can be collected as in the example above).
- The approved request should be sent as soon as possible as BuckEye is not an ISR platform, but a wide area mapping platform (Waiting to provide the request does not benefit anyone but delays the data making it to the customer).
- **BuckEye provides UNCLASSIFIED//FOUO high-resolution and high-accuracy color imagery for tactical missions.**

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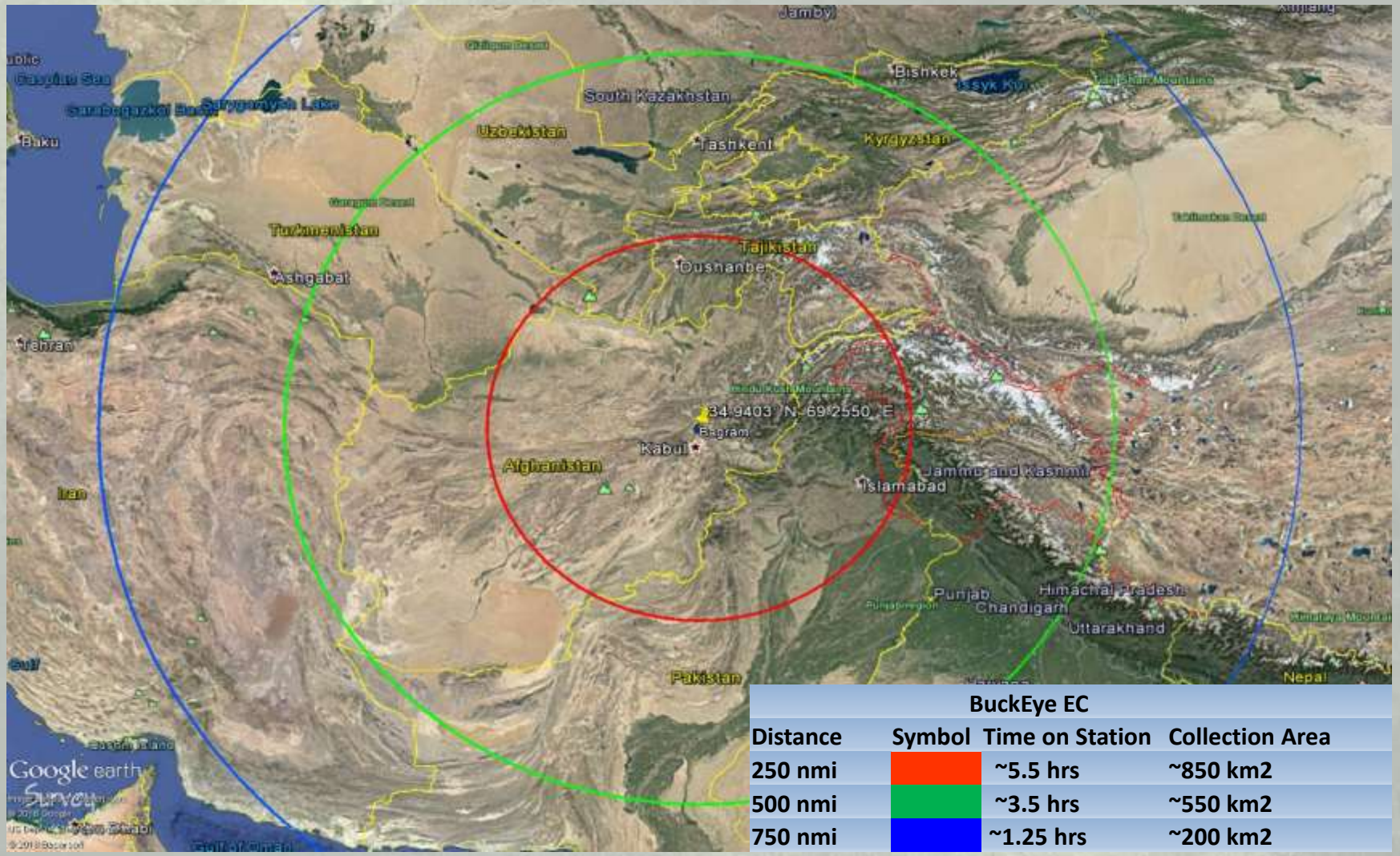
BuckEye EC Range

Bagram AF (CENTCOM)



BuckEye EC			
Distance	Symbol	Time on Station	Collection Area
250 nmi		~5.5 hrs	~850 km2
500 nmi		~3.5 hrs	~550 km2
750 nmi		~1.25 hrs	~200 km2

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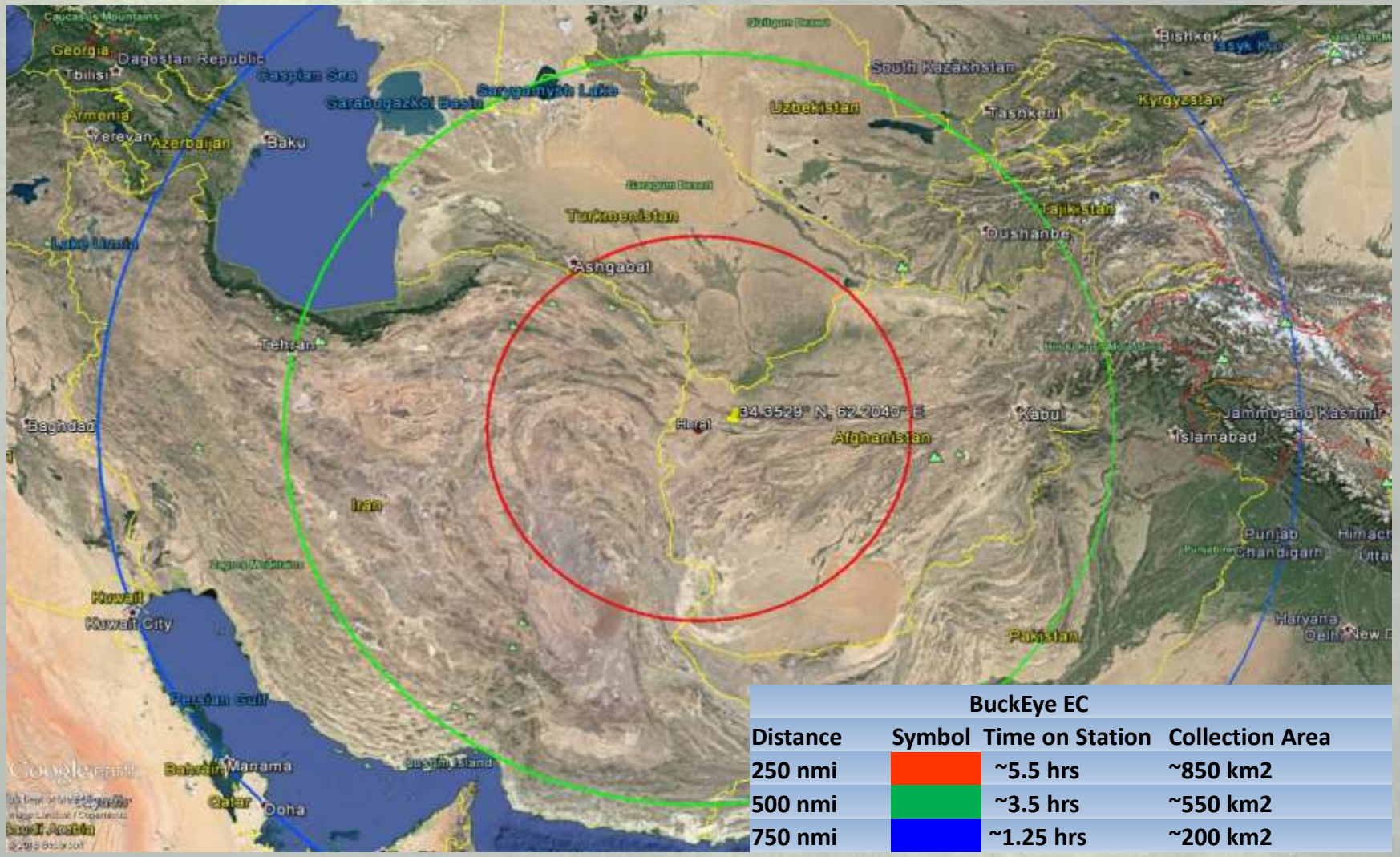
BuckEye EC Range

Herat AF (CENTCOM)



BuckEye EC			
Distance	Symbol	Time on Station	Collection Area
250 nmi		~5.5 hrs	~850 km2
500 nmi		~3.5 hrs	~550 km2
750 nmi		~1.25 hrs	~200 km2

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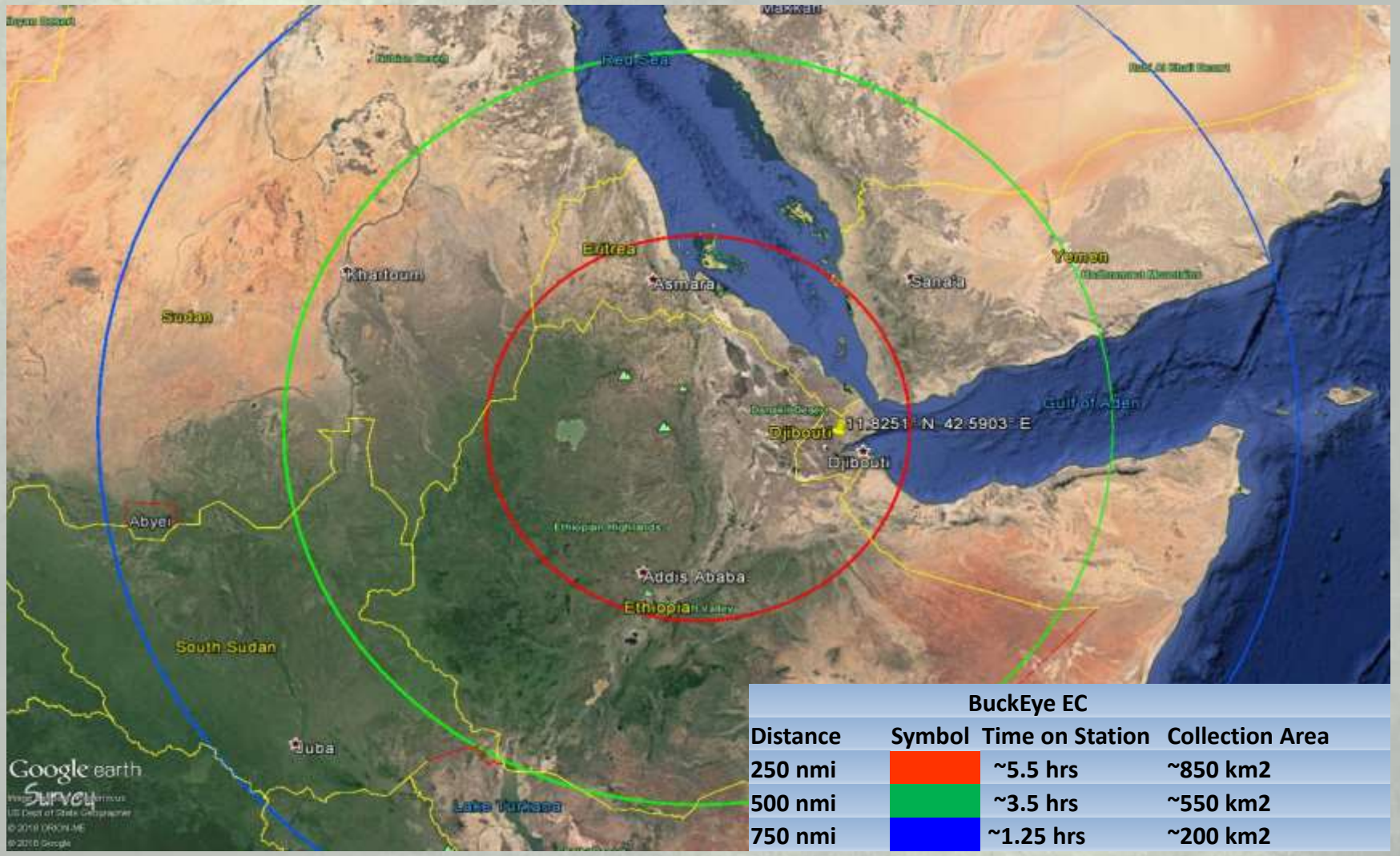
BuckEye EC Range

Djibouti (AFRICOM)



BuckEye EC			
Distance	Symbol	Time on Station	Collection Area
250 nmi		~5.5 hrs	~850 km2
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750 nmi		~1.25 hrs	~200 km2

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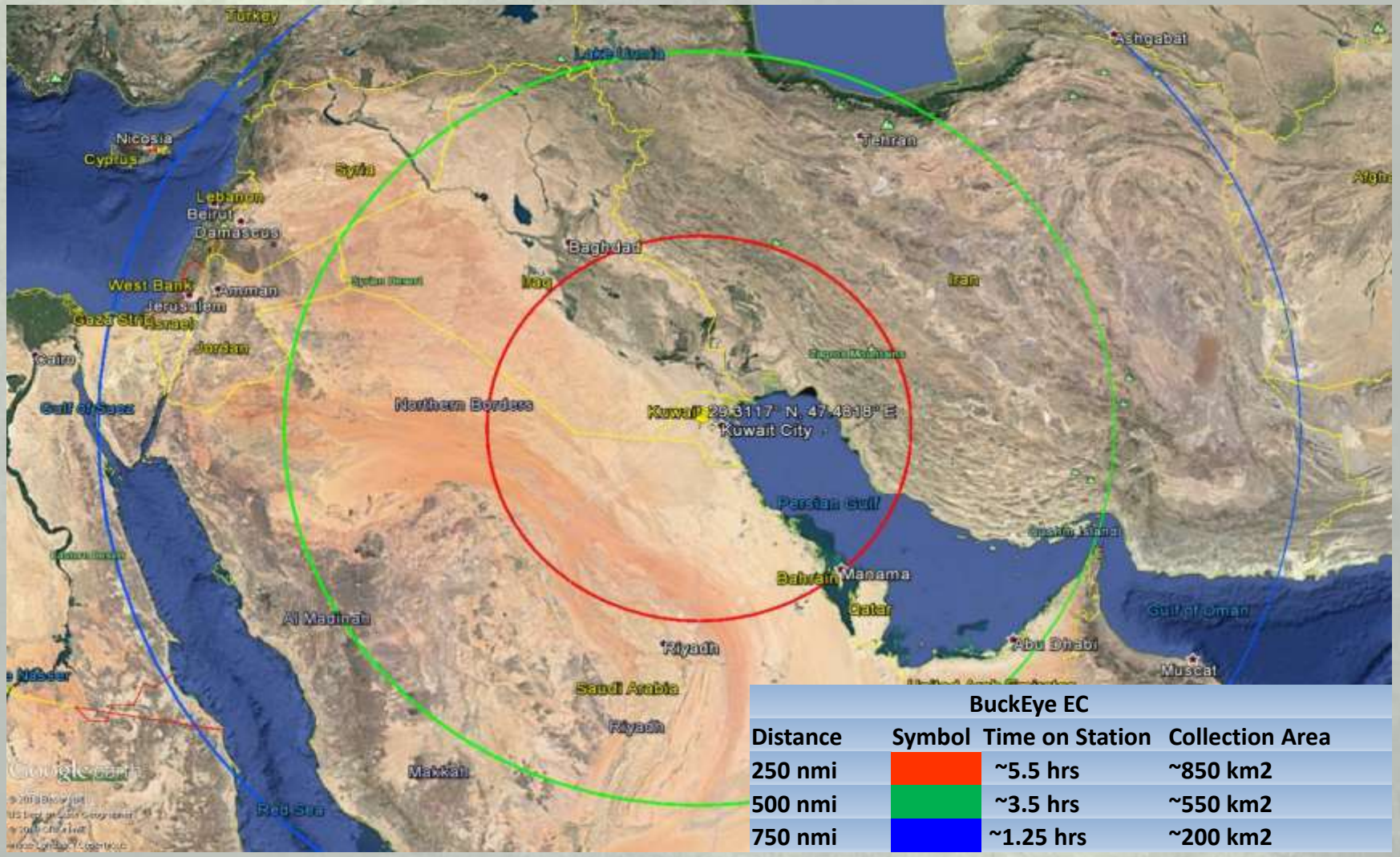
BuckEye EC Range

Kuwait (CENTCOM)



BuckEye EC			
Distance	Symbol	Time on Station	Collection Area
250 nmi		~5.5 hrs	~850 km2
500 nmi		~3.5 hrs	~550 km2
750 nmi		~1.25 hrs	~200 km2

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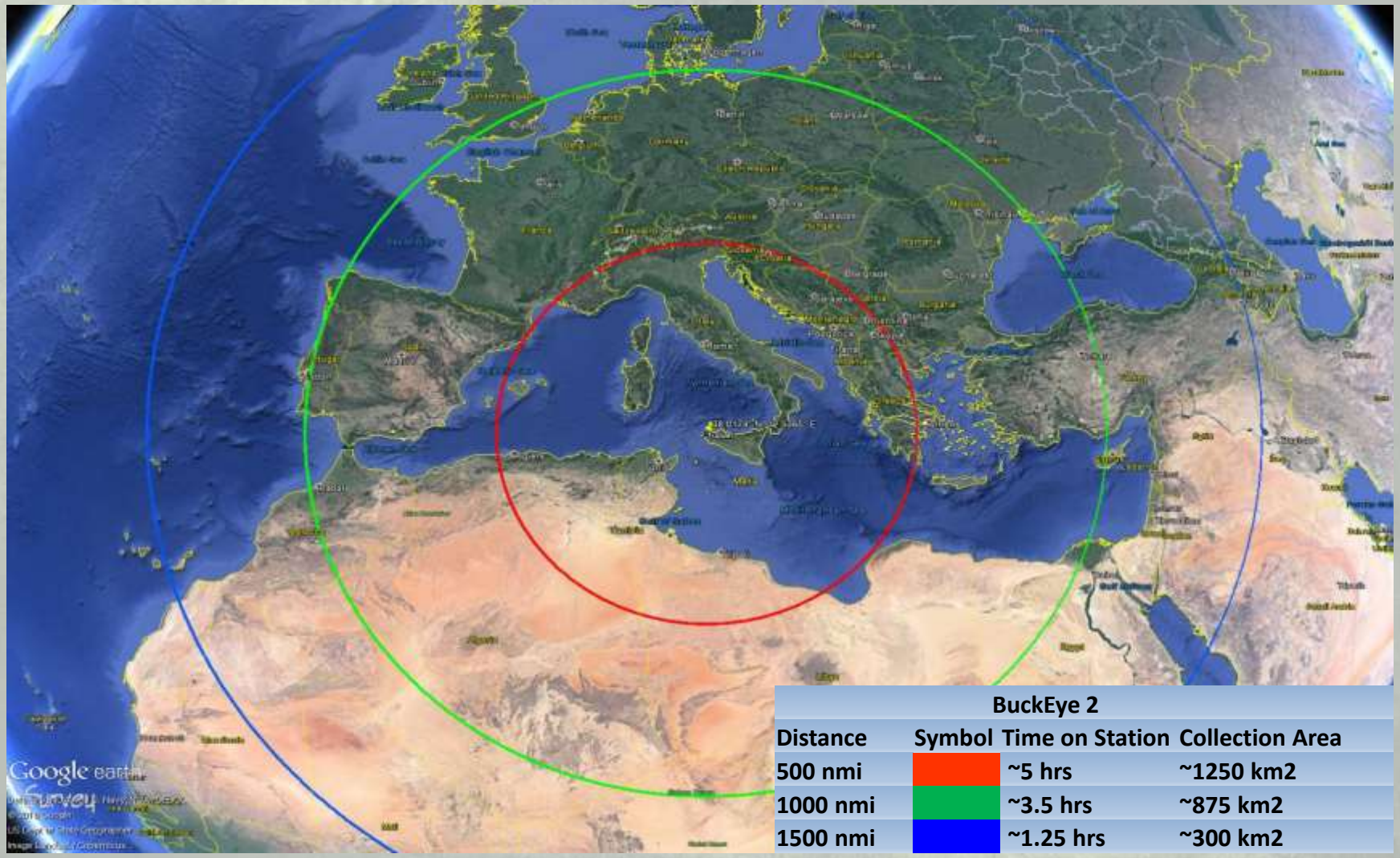
BuckEye 2 Range

Trapani (AFRICOM Asset)



BuckEye 2			
Distance	Symbol	Time on Station	Collection Area
500 nmi		~5 hrs	~1250 km2
1000 nmi		~3.5 hrs	~875 km2
1500 nmi		~1.25 hrs	~300 km2

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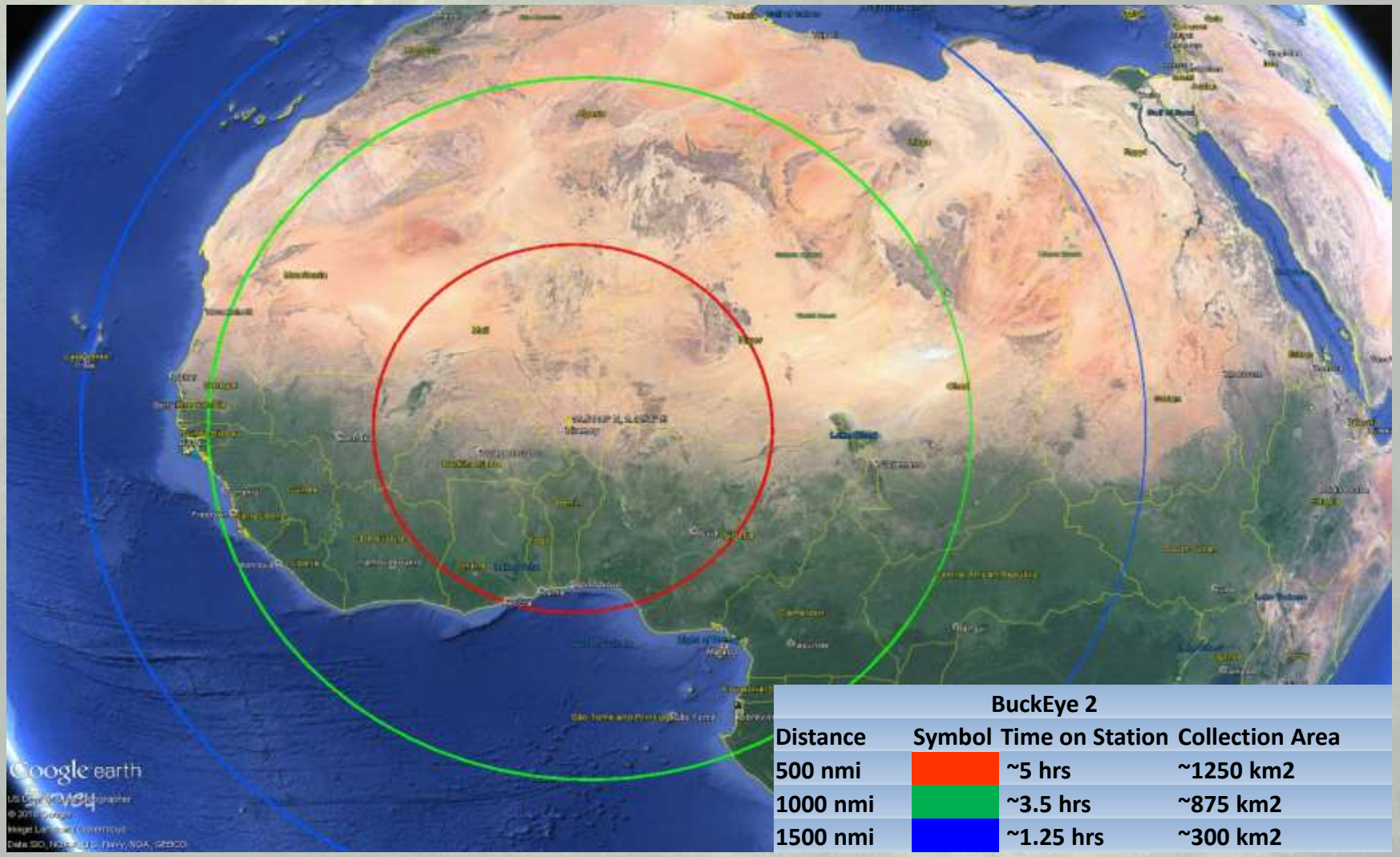
BuckEye 2 Range

Niamey (BE2 from Trapani)



BuckEye 2			
Distance	Symbol	Time on Station	Collection Area
500 nmi		~5 hrs	~1250 km2
1000 nmi		~3.5 hrs	~875 km2
1500 nmi		~1.25 hrs	~300 km2

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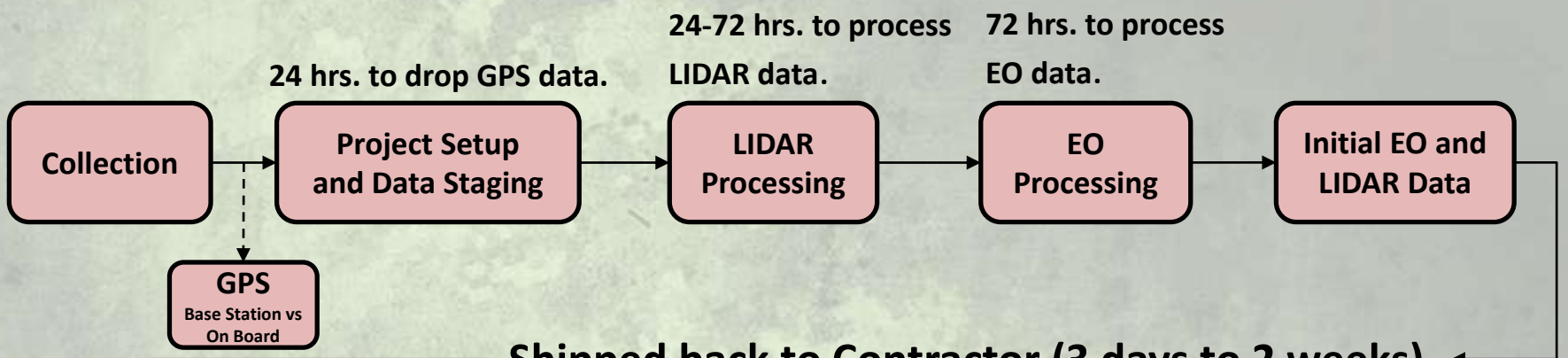
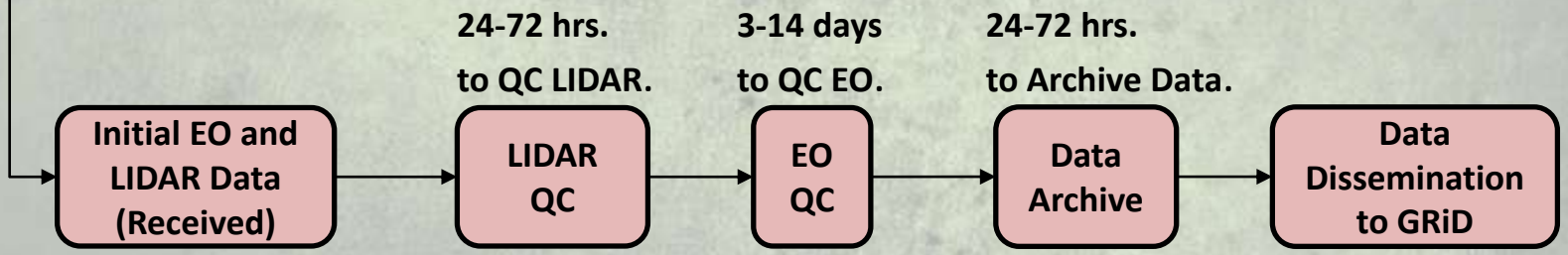
BuckEye Processing

BuckEye Processing

Timeline at Site



Timeline at Contractor



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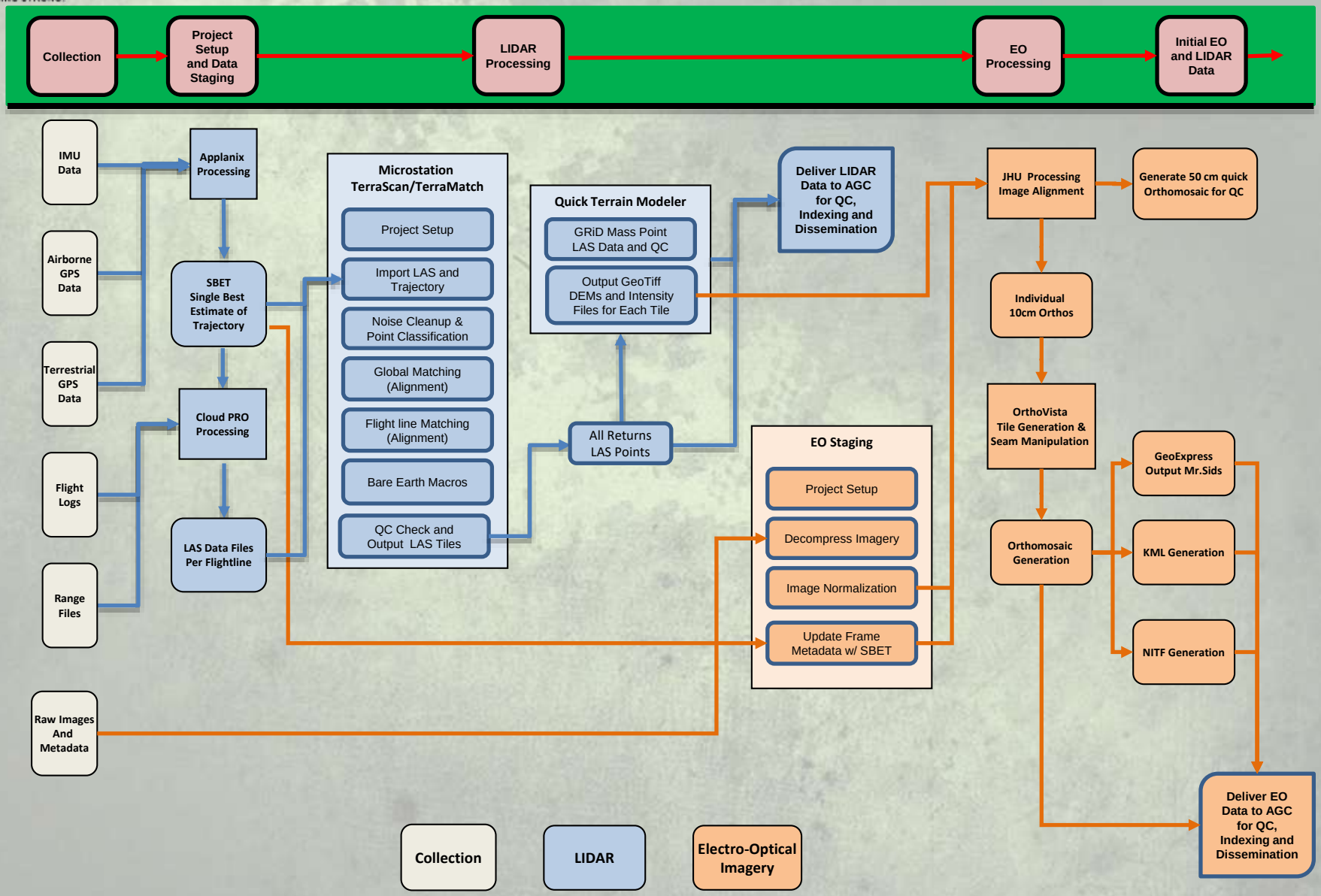
BuckEye Processing



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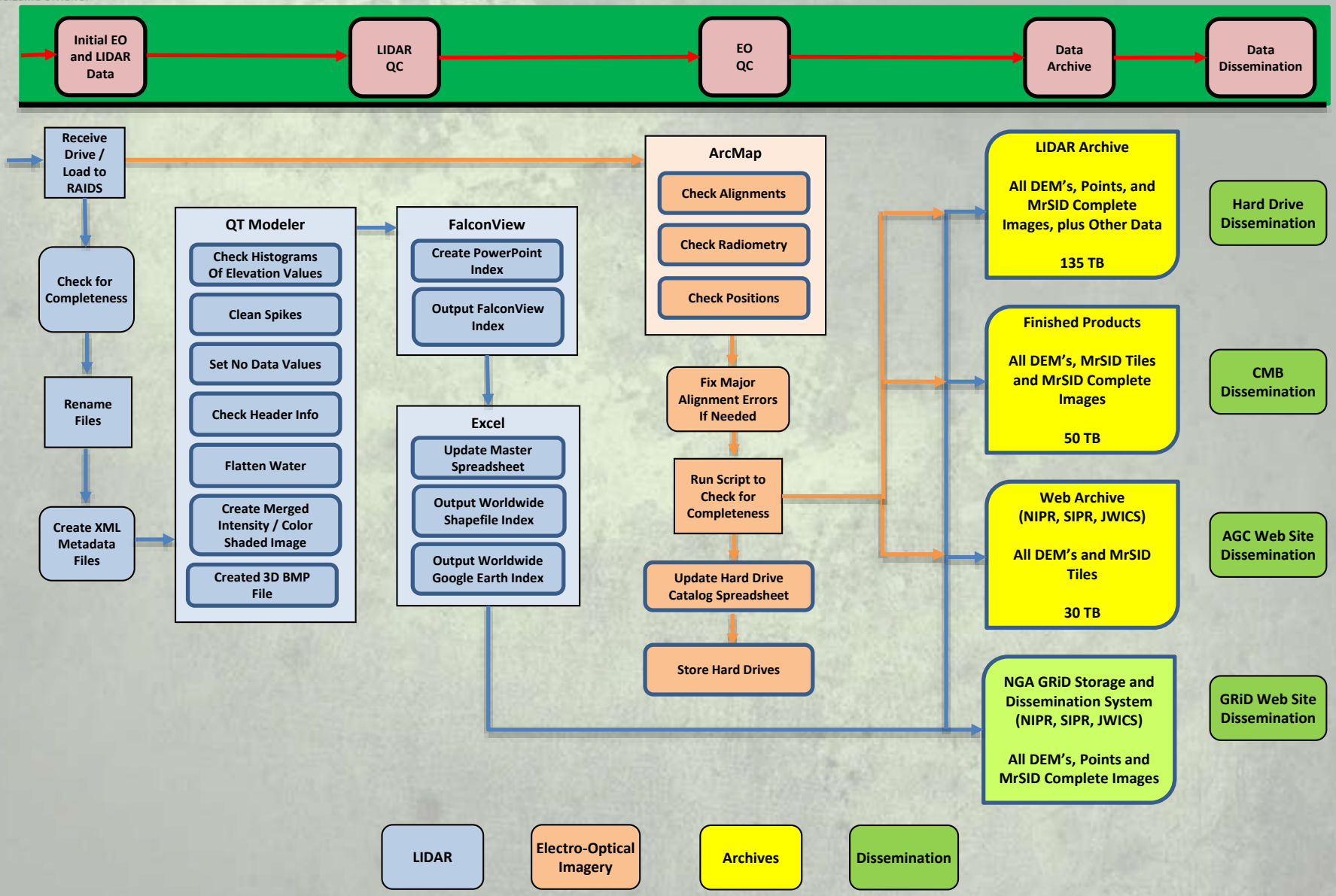
BuckEye QC & Dissemination



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BuckEye Products and Exploitation

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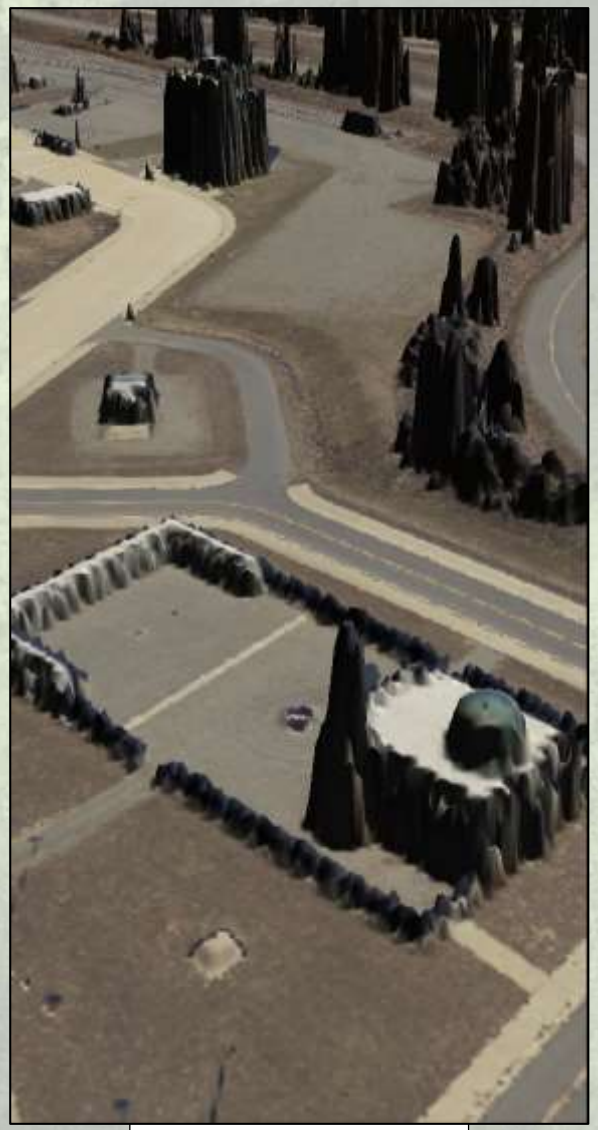
BuckEye 2 Data (25,000 ft)

Point Cloud with Image



DSM with Image (50cm)

Color Image (10cm)

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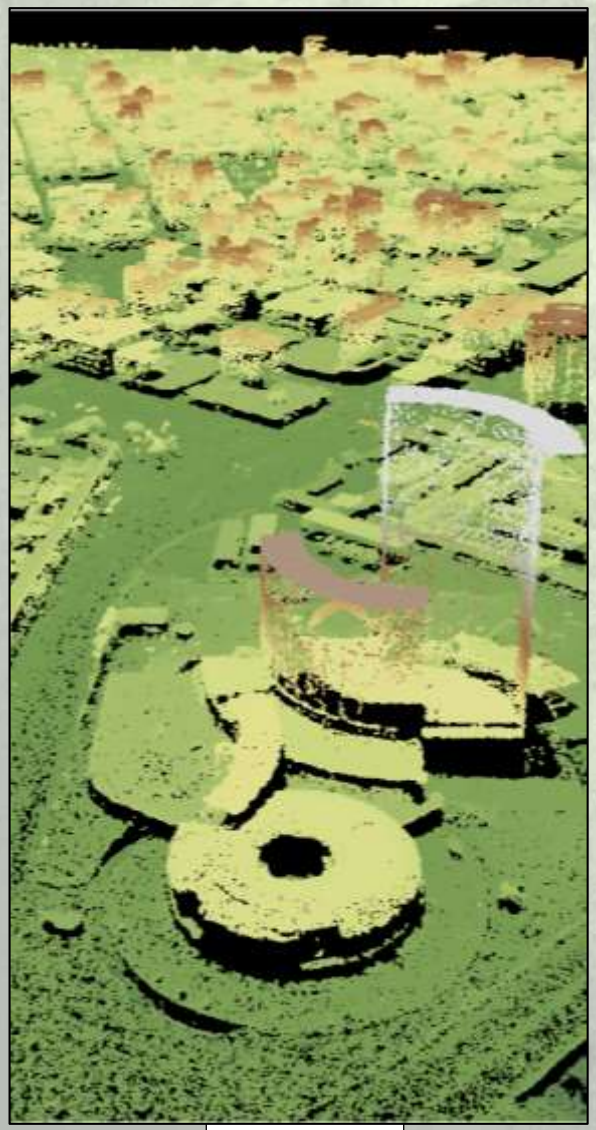
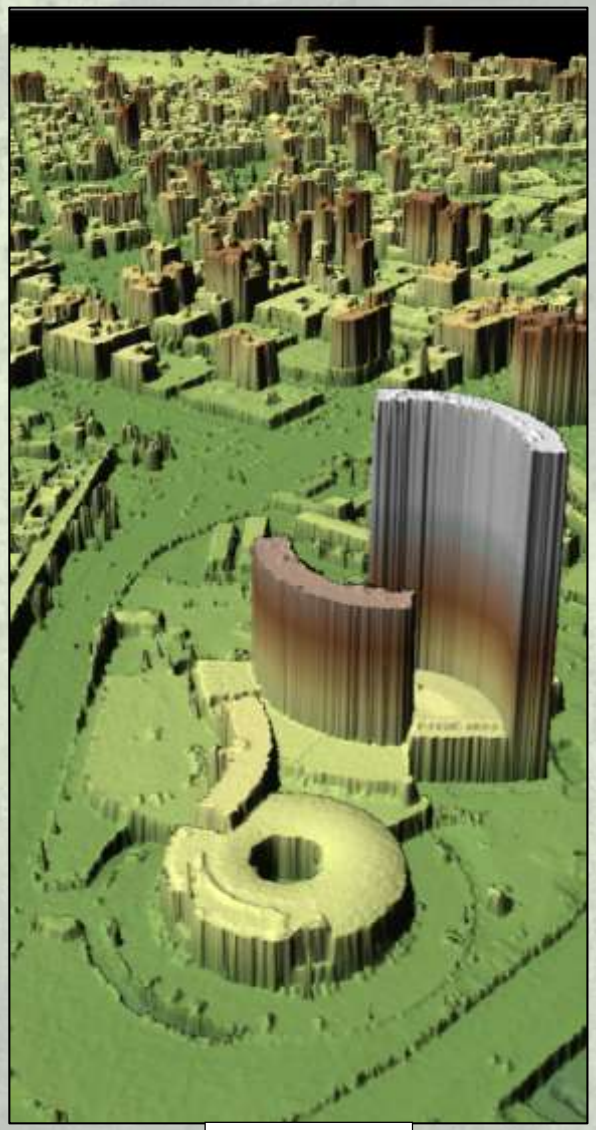
BuckEye EC Data (18,000 ft)



Point Cloud



DSM (50cm)

Color Image (10cm)

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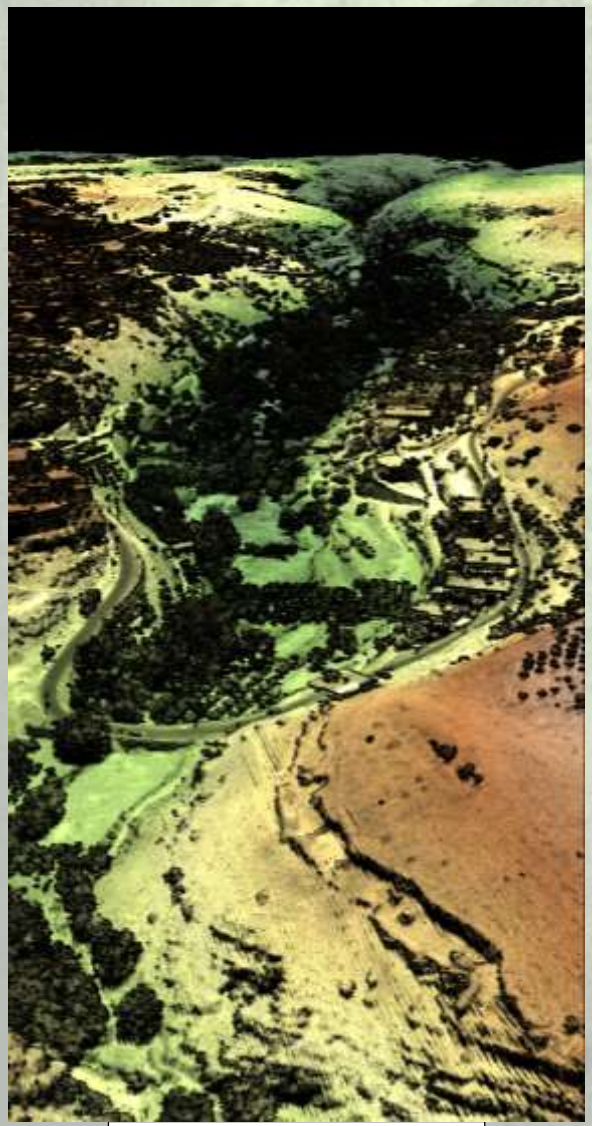
BuckEye UAS Data (5,000 ft)



Point Cloud with intensity

DSM with intensity (50cm)

Color Image (10cm)

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BuckEye Terrestrial Data

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BuckEye OrthoMosaic

Orthomosaic maps are a grouping of many overlapping images of a defined area which are processed to create a new, larger "**orthomosaic**": a highly detailed **map** that is in true scale.

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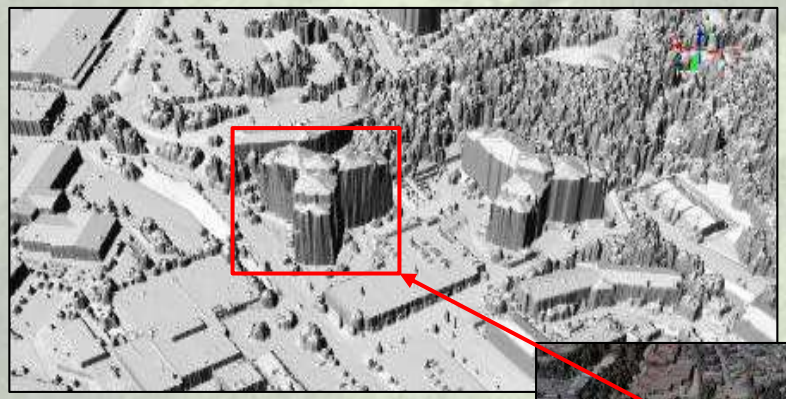
BuckEye LIDAR Products

DEM

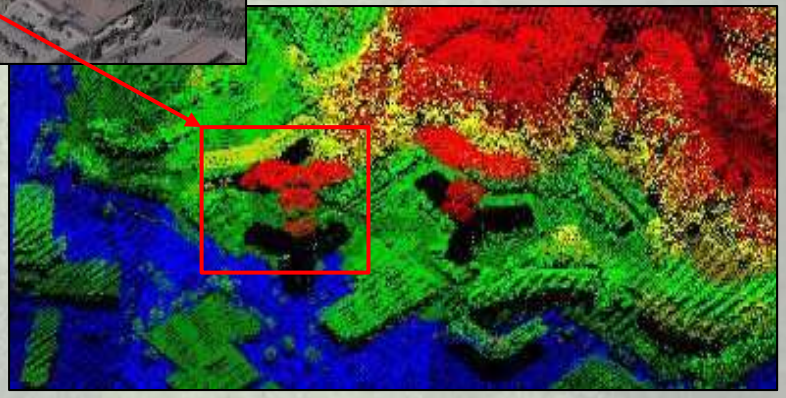


Bare Earth

Imagery Overlaid On DEM

Point Clouds

Point Clouds Displayed as Elevation



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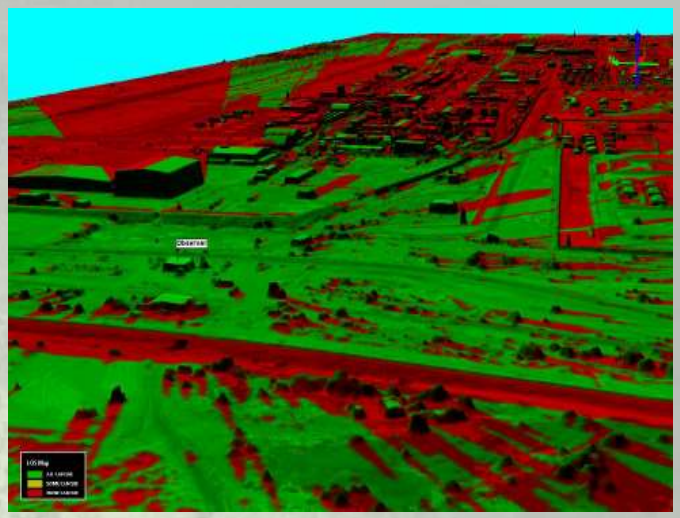
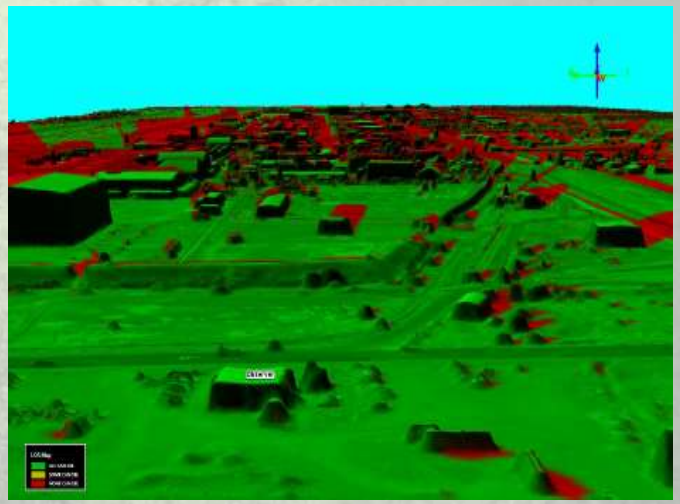
Line of Sight (LOS) Analysis



The LOS analysis provides a visual representation of what an observer can see from a physical chosen location. This representation can be used for physical security, route planning, and overlook positions.



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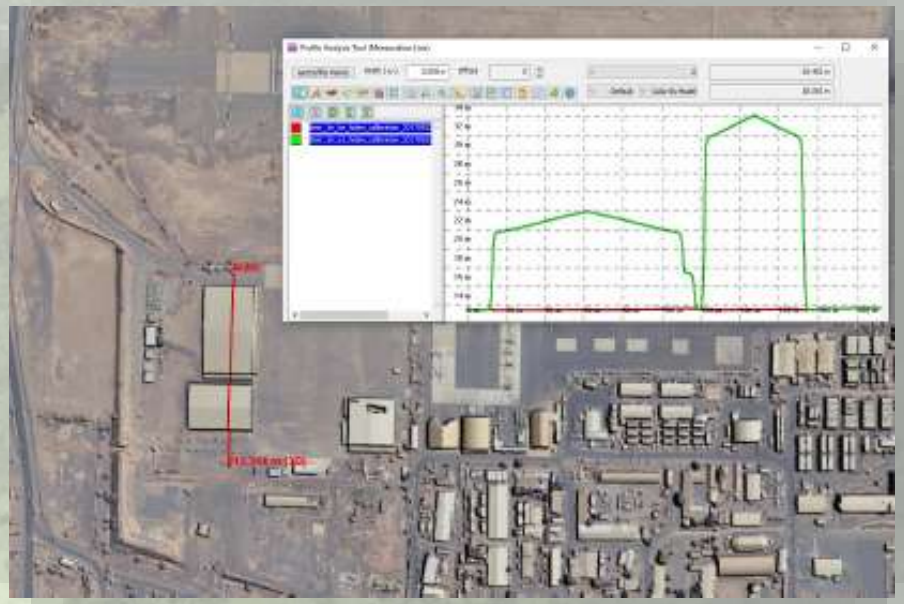
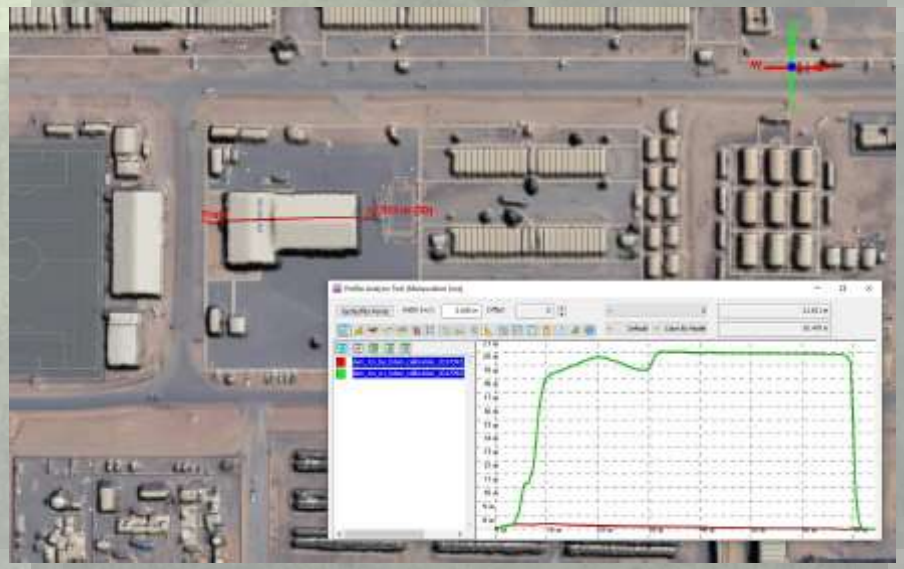
Profile Analysis

The profile analysis provides the xyz (height, width, length) data on the selected buildings. An essential tool in mission planning, this can be used to identify overview positions, in assault planning, and mission analysis.





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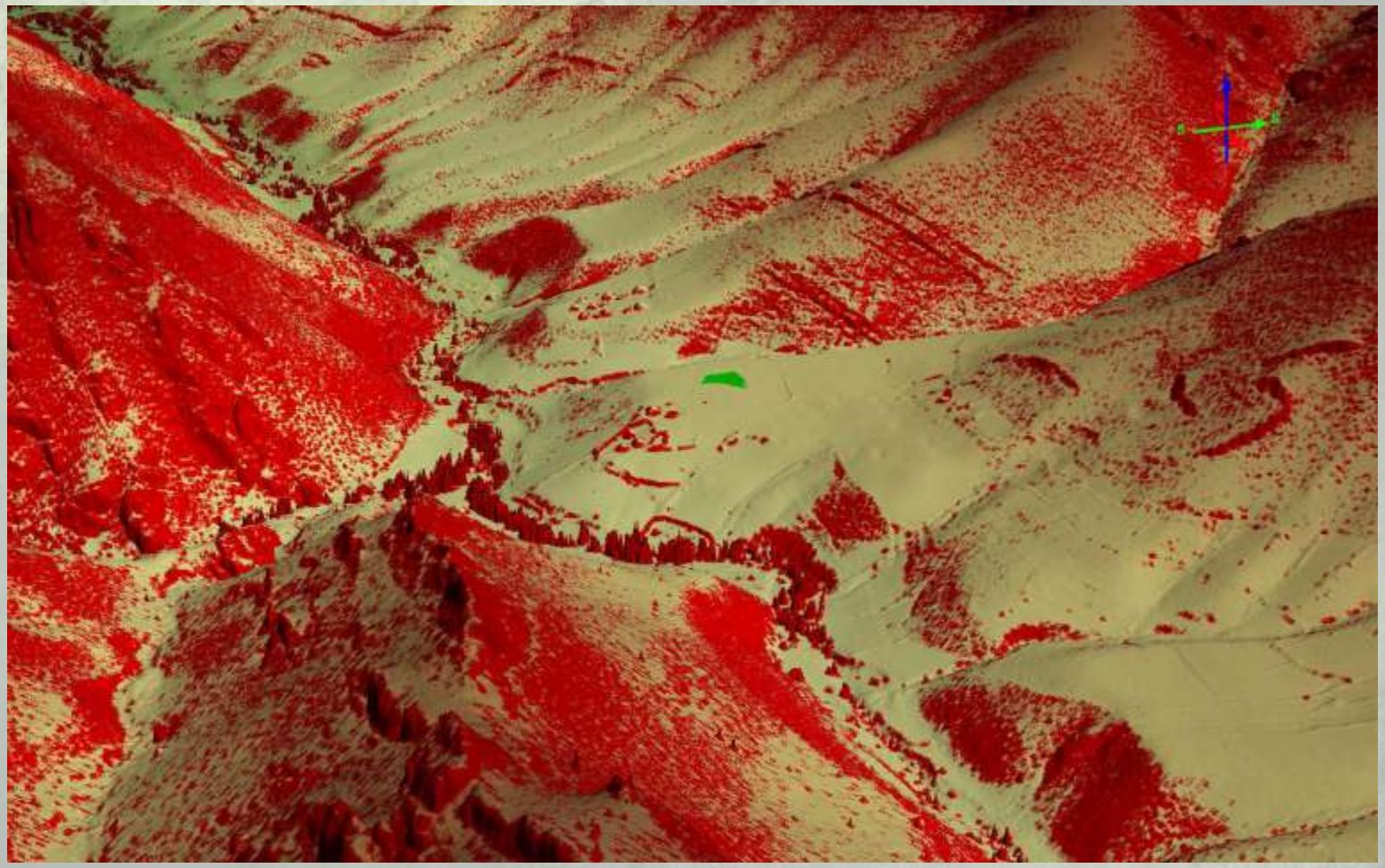
Slope Analysis

The slope analysis provides route planning capabilities, identifying slopes that may be impassible to vehicles/personnel.



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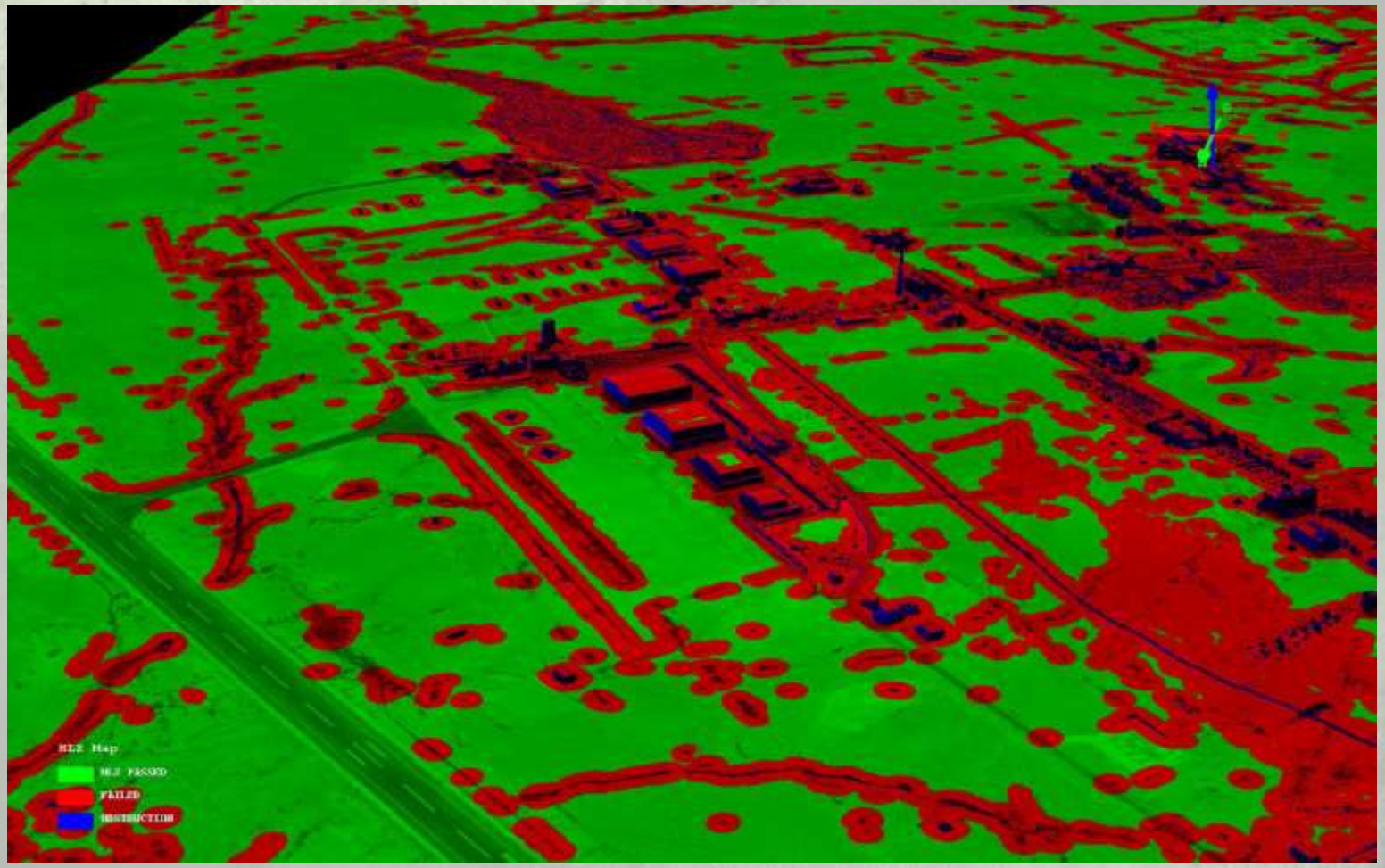
Helicopter Landing Zone (HLZ) Analysis

The HLZ analysis provides landing zones that are free of obstructions. In planning mission support, medical evacuations, etc., this can minimize support time in identifying a suitable landing zone.



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Fly Through Video Tripoli

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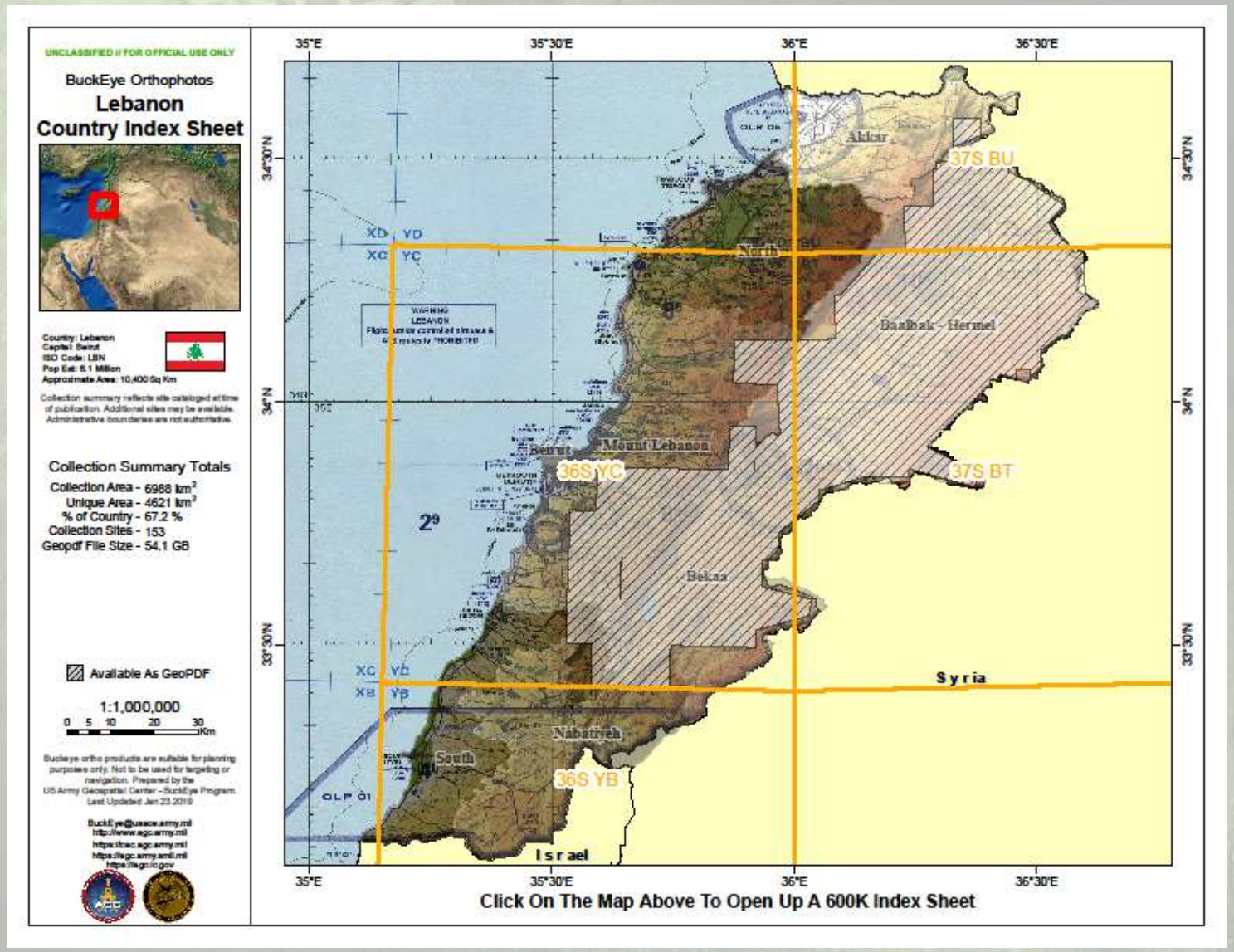
GeoPDF Mapbook Lebanon



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BuckEye Dissemination

BuckEye HR3D Resources

Resource	Data Access	Network	URL(s)
AGC Websites	Individual File Download	NIPR	https://cac.agc.army.mil/
		SIPR	http://agc.army.smil.mil/
		JWICS	http://agc.ic.gov/
CMB & CMB Online	Bulk Data Shipment & Download	NIPR	http://agcwfs.agc.army.mil/CMB_Online/default.html
		SIPR	https://agcwfs.agc.army.smil.mil/CMB_Online/default.html
GRiD	Bulk Data Download	NIPR	https://griduc.rsgis.erdc.dren.mil/griduc
		SIPR	http://grid.nga.smil.mil/gridsw1
		JWICS	http://grid.nga.ic.gov
Direct Contact & In theater	Bulk Data Shipment	NIPR	BuckEye@usace.army.mil

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BuckEye Final Product

(AGC Website)

BuckEye Imagery Download
NIPR: https://cac.agc.army.mil/Products/BuckEye/index.cfm
SIPR: https://www.agc.smil.mil/Products/BuckEye/index.cfm
JWICS: http://www.agc.ic.gov/Products/BuckEye/index.cfm

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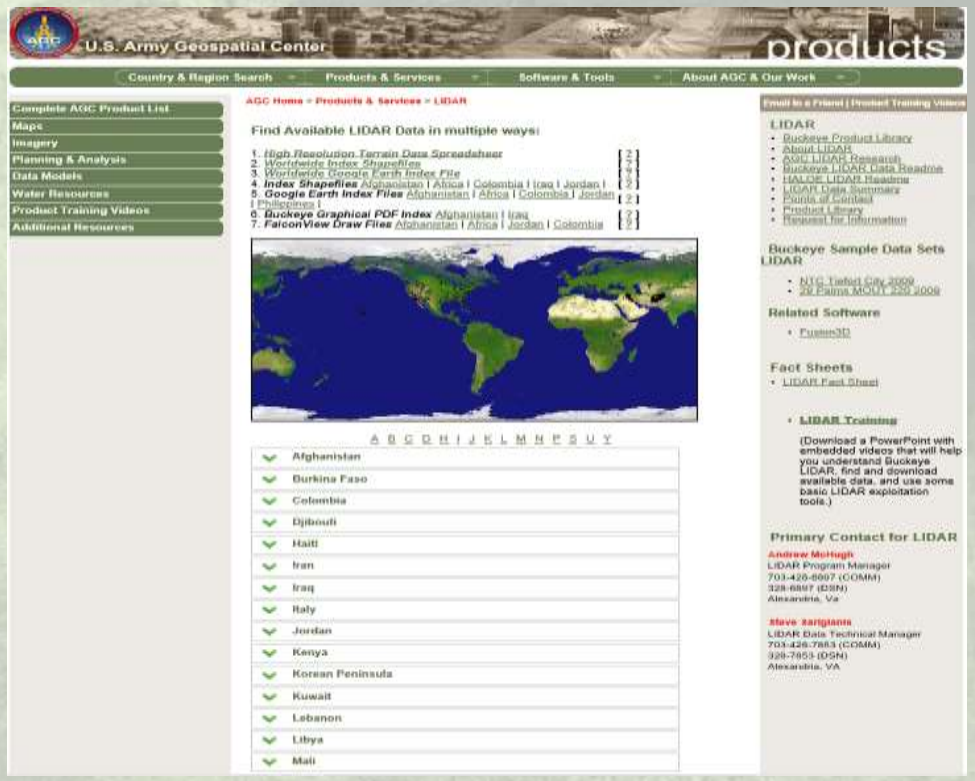
LIDAR Final Product

(AGC Website)



BuckEye LIDAR Download

NIPR: https://cac.agc.army.mil/Products/LIDAR/index.cfm

SIPR: http://www.agc.army.smil.mil/Products/LIDAR/index.cfm

JWICS: http://www.agc.ic.gov/Products/LIDAR/index.cfm

CMB & CMB Online

- CMB online allows for individual or bulk file downloads.
- Customers who have a large request or need assistance with determining their data requirements should contact the CMB program directly.
- Customers can also use CMB program to download a variety of other datasets including Control Image Base (CIB), Arc Digital Raster Graphics (ADGR), Compressed ADRG (CADRG)/Enhanced Compressed Raster Graphics (ECRG), Digital Terrain Elevation Data (DTED), Urban Tactical Planners (UTPs), Engineering Routes Studies, and Water Resources data. BuckEye data is only available in BMT and High-Resolution Terrain Elevation 5 (HRTE5) formats through CMB online.

- NIPR: https://agcwfs.agc.army.mil/CMB_Online/default.html
- SIPR: http://agcwfs.agc.army.smil.mil/CMB_Online/default.html

GRiD

- The Geospatial Repository and Data Management System (GRiD) was developed by NGA to create a web-based 3D data warehouse capable of serving LIDAR point cloud data on demand. As GRiD matured, it became capable of serving raster and vector data.
- Users must establish a GRiD account. Once in the GRiD Map interface, a user selects an Area of Interest (AOI) and data layer of interest. GRiD packages data and the user downloads the file or initiates a File Transfer Protocol (FTP) push.
- GRiD limits users to 50 GB a day for downloads.
- GRiD also produces Tactical Decision Aids (TDA's) on demand.

- NIPR: https://griduc.rsgis.erdc.dren.mil/griduc
- SIPR: http://grid.nga.smil.mil
- JWICS: http://grid.nga.ic.gov

Direct Contact & In Theater

(Non-Standard Delivery of Data)

- BuckEye data can be obtained directly by contacting the AGC or one of our deployed locations.
- BuckEye data is processed in theater, timeline for availability is determined by each site. Downrange this may be an effective way to get the data, as often the bandwidth back to the United States (U.S.) for automated systems is limited.
- If you are unable to locate BuckEye data in GRiD, contact AGC at BuckEye@usace.army.mil

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Current Deployments

Current Deployments

BuckEye UAS:

- **Yuma, Arizona**
  - Awaiting requirements

BuckEye EC:

- **Afghanistan:**
  - Bagram: FL 418
  - Herat: FL 413
- **Camp Lemonnier, Djibouti:**
  - FL 405 Collecting Somalia
- **Ali Al Salem air base, Kuwait:**
  - FL 406 Collecting in Iraq and Syria

BuckEye 2:

- **Trapani, Sicily:**
  - Collecting Northern Africa
  - Completed collection into Southern Somalia from Djibouti

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Points of Contacts

BuckEye HR3D POC's

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BuckEye@usace.army.mil

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Questions